CLAIMS

What is claimed is:

1. A plasma arc torch comprising:

an electrode;

a tip; and

an initiator in electrical contact with the electrode and in contact with the tip, the initiator being movable to separate from the tip and establish a pilot arc between the initiator and the tip.

2. The plasma arc torch according to Claim 1, wherein the tip defines a generally conical surface and the initiator defines a beveled contact surface, such that the beveled contact surface engages the generally conical surface when the initiator is biased into contact with the tip.

3. The plasma arc torch according to Claim 1 further comprising a start cartridge disposed between the electrode and the tip, the start cartridge comprising:

a cartridge assembly;

a biasing member disposed within the cartridge assembly; and

the initiator being disposed within the cartridge assembly,

wherein the biasing member biases the initiator into contact with the tip.

4. The plasma arc torch according to Claim 3, wherein the cartridge assembly further comprises a cartridge body defining a plurality of radial gas holes that direct a portion of a working gas into the start cartridge to overcome the bias of the spring to separate the initiator from the tip.

5. The plasma arc torch according to Claim 4, wherein the cartridge body further comprises a plurality of axial vent holes to vent a working gas from the start cartridge.

6. The plasma arc torch according to Claim 5, wherein the cartridge body further comprises a plurality of proximal radial holes to direct the working gas.

7. The plasma arc torch according to Claim 4, wherein the cartridge body further comprises an internal annular flange and at least one gas passage formed in the cartridge body that vent a portion of the along a central portion of the electrode and through the start cartridge.

8. The plasma arc torch according to Claim 3, wherein the cartridge assembly further comprises a cartridge body defining a plurality of gas passages that direct a portion of a working gas into the start cartridge to overcome the bias of the spring to separate the initiator from the tip.

9. The plasma arc torch according to Claim 8, wherein the cartridge body further comprises a plurality of axial vent holes to vent a working gas from the start cartridge.

10. The plasma arc torch according to Claim 9, wherein the cartridge body further comprises a plurality of proximal radial holes to direct the working gas.

11. The plasma arc torch according to Claim 8, wherein the cartridge body further comprises an internal annular flange and at least one gas passage formed in the cartridge body that vent a portion of the working gas along a central portion of the electrode and through the start cartridge.

12. The plasma arc torch according to Claim 3, wherein the cartridge assembly further comprises a cartridge body and a tip seat secured to a distal portion of the cartridge body.

13. The plasma arc torch according to Claim 12, wherein the cartridge body is conductive and the tip seat is insulative.

14. The plasma arc torch according to Claim 12, wherein the cartridge assembly further comprises a conductive member disposed at a proximal end of the cartridge body, and the cartridge body and the tip seat are insulative.

15. The plasma arc torch according to Claim 1, wherein the initiator further comprises a plurality of vent holes that direct a portion of the working gas along a central portion of the electrode.

16. The plasma arc torch according to Claim 1, wherein the biasing member is a coil spring.

17. The plasma arc torch according to Claim 1, wherein the tip defines swirl holes to direct a primary working gas into a primary gas passage formed between the electrode and the tip to form a plasma stream, and secondary gas holes to direct a secondary gas distally along the tip to stabilize the plasma stream.

18. A plasma arc torch comprising:

an electrode;

a tip; and

a start cartridge disposed between the electrode and the tip, the start cartridge further comprising:

a cartridge assembly;

a biasing member disposed within the cartridge assembly; and

an initiator disposed within the cartridge assembly, the initiator being resiliently biased into contact with the tip by the biasing member, the initiator being movable against the resilient bias to separate from the tip and establish a pilot arc between the initiator and the tip.

19. The plasma arc torch according to Claim 18, wherein the cartridge assembly further comprises a cartridge body defining a plurality of radial gas holes that direct a portion of a working gas into the start cartridge to overcome the bias of the spring to separate the initiator from the tip.

20. The plasma arc torch according to Claim 19, wherein the cartridge body further comprises a plurality of axial vent holes to vent a working gas from the start cartridge.

21. The plasma arc torch according to Claim 20, wherein the cartridge body further comprises a plurality of proximal radial holes to direct the working gas.

22. The plasma arc torch according to Claim 19, wherein the cartridge body further comprises an internal annular flange and at least one gas passage formed in the cartridge body that vent a portion of the working gas along a central portion of the electrode and through the start cartridge.

23. The plasma arc torch according to Claim 18, wherein the cartridge assembly further comprises a cartridge body defining a plurality of gas passages that direct a portion of a working gas into the start cartridge to overcome the bias of the spring to separate the initiator from the tip.

24. The plasma arc torch according to Claim 23, wherein the cartridge body further comprises a plurality of axial vent holes to vent a working gas from the start cartridge.

25. The plasma arc torch according to Claim 24, wherein the cartridge body further comprises a plurality of proximal radial holes to direct the working gas.

26. The plasma arc torch according to Claim 23, wherein the cartridge body further comprises an internal annular flange and at least one gas passage formed in the cartridge body that vent a portion of the working gas along a central portion of the electrode and through the start cartridge.

27. The plasma arc torch according to Claim 18, wherein the initiator further comprises a plurality of vent holes that direct a portion of the working gas along a central portion of the electrode.

28. The plasma arc torch according to Claim 18, wherein the biasing member is a coil spring.

29. The plasma arc torch according to Claim 18, wherein the tip defines swirl holes to direct a primary working gas into a primary gas passage formed between the electrode and the tip to form a plasma stream, and secondary gas holes to direct a secondary gas distally along the tip to stabilize the plasma stream.

30. The plasma arc torch according to Claim 18, wherein the tip defines a generally conical surface and the initiator defines a beveled contact surface, such that the beveled contact surface engages the generally conical surface when the initiator is biased into contact with the tip.

31. The plasma arc torch according to Claim 18, wherein the cartridge assembly further comprises a cartridge body and a tip seat secured to a distal portion of the cartridge body.

32. The plasma arc torch according to Claim 31, wherein the cartridge body is conductive and the tip seat is insulative.

33. The plasma arc torch according to Claim 31, wherein the cartridge assembly further comprises a conductive member disposed at a proximal end of the cartridge body, and the cartridge body and the tip seat are insulative.

34. A start cartridge for use in initiating a pilot arc in a plasma arc torch comprising:

a cartridge assembly;

a biasing member disposed within the cartridge assembly; and

an initiator disposed within the cartridge assembly, the initiator being resiliently biased such that the initiator is movable against the resilient bias to establish a pilot arc between the initiator and a tip within the plasma arc torch.

35. The start cartridge according to Claim 34, wherein the cartridge assembly further comprises a cartridge body and a tip seat secured to a distal portion of the cartridge body.

36. The start cartridge according to Claim 35, wherein the cartridge body further comprises a plurality of radial gas holes that direct a portion of a working gas into the start cartridge to overcome the bias of the biasing member to move the initiator.

37. The start cartridge according to Claim 35, wherein the cartridge body further comprises a plurality of gas passages that direct a portion of a working gas into the start cartridge to overcome the bias of the spring to separate the initiator from the tip.

38. The start cartridge according to Claim 35, wherein the cartridge body further comprises a plurality of axial vent holes to vent a working gas from the start cartridge.

39. The start cartridge according to Claim 38, wherein the cartridge body further comprises a plurality of proximal radial holes to direct the working gas.

40. The start cartridge according to Claim 35, wherein the cartridge body further comprises an internal annular flange and at least one gas passage formed in the cartridge body that vent a portion of the working gas along a central portion of the electrode and through the start cartridge.

41. The start cartridge according to Claim 35, wherein the cartridge body is conductive and the tip seat is insulative.

42. The start cartridge according to Claim 35, wherein the cartridge assembly further comprises a conductive member disposed at a proximal end of the cartridge body, and the cartridge body and the tip seat are insulative.

43. The start cartridge according to Claim 34, wherein initiator further comprises a plurality of vent holes that direct a portion of the working gas along a central portion of the electrode.

44. The start cartridge according to Claim 34, wherein the biasing member is a coil spring.

45. The start cartridge according to Claim 34, wherein the initiator defines a beveled contact surface.

46. A start cartridge for use in initiating a pilot arc in a plasma arc torch comprising:

a cartridge body;

a tip seat secured to a distal portion of the cartridge body;

a biasing member disposed within the cartridge body; and

an initiator disposed within the cartridge body, the initiator being resiliently biased such that the initiator is movable against the resilient bias to establish a pilot arc between the initiator and a tip within the plasma arc torch.

47. The start cartridge according to Claim 46, wherein the cartridge body further comprises a plurality of radial gas holes that direct a portion of a working gas into the start cartridge to overcome the bias of the biasing member to move the initiator.

48. The start cartridge according to Claim 46, wherein the cartridge body further comprises a plurality of gas passages that direct a portion of a working gas into the start cartridge to overcome the bias of the spring to separate the initiator from the tip.

49. The start cartridge according to Claim 46, wherein the cartridge body further comprises a plurality of axial vent holes to vent a working gas from the start cartridge.

50. The start cartridge according to Claim 49, wherein the cartridge body further comprises a plurality of proximal radial holes to direct the working gas.

51. The start cartridge according to Claim 46, wherein the cartridge body further comprises an internal annular flange and at least one gas passage formed in the cartridge body that vent a portion of the working gas along a central portion of the electrode and through the start cartridge.

52. The start cartridge according to Claim 46, wherein the cartridge body is conductive and the tip seat is insulative.

53. The start cartridge according to Claim 46, wherein the cartridge assembly further comprises a conductive member disposed at a proximal end of the cartridge body, and the cartridge body and the tip seat are insulative.

54. The start cartridge according to Claim 46, wherein initiator further comprises a plurality of vent holes that direct a portion of the working gas along a central portion of the electrode.

55. The start cartridge according to Claim 46, wherein the biasing member is a coil spring.

56. The start cartridge according to Claim 46, wherein the initiator defines a beveled contact surface.

57. A start cartridge for use in initiating a pilot arc in a plasma arc torch comprising:

a cartridge assembly; and

an initiator disposed within the cartridge assembly, the initiator being resiliently biased such that the initiator is movable against the resilient bias to establish a pilot arc between the initiator and a tip within the plasma arc torch.

58. The start cartridge according to Claim 57, wherein the cartridge assembly further comprises a cartridge body and a tip seat secured to a distal portion of the cartridge body.

59. The start cartridge according to Claim 58, wherein the cartridge body further comprises a plurality of radial gas holes that direct a portion of a working gas into the start cartridge to overcome the bias of the biasing member to move the initiator.

60. The start cartridge according to Claim 58, wherein the cartridge body further comprises a plurality of gas passages that direct a portion of a working gas into the start cartridge to overcome the bias of the spring to separate the initiator from the tip.

61. The start cartridge according to Claim 58, wherein the cartridge body further comprises a plurality of axial vent holes to vent a working gas from the start cartridge.

62. The start cartridge according to Claim 61, wherein the cartridge body further comprises a plurality of proximal radial holes to direct the working gas.

63. The start cartridge according to Claim 58, wherein the cartridge body further comprises an internal annular flange and at least one gas passage formed in the cartridge body that vent a portion of the working gas along a central portion of the electrode and through the start cartridge.

64. The start cartridge according to Claim 58, wherein the cartridge body is conductive and the tip seat is insulative.

65. The start cartridge according to Claim 58, wherein the cartridge assembly further comprises a conductive member disposed at a proximal end of the cartridge body, and the cartridge body and the tip seat are insulative.

66. The start cartridge according to Claim 57, wherein initiator further comprises a plurality of vent holes that direct a portion of the working gas along a central portion of the electrode.

67. The start cartridge according to Claim 57 further comprising a biasing member disposed within the cartridge assembly, the biasing member resiliently biasing the initiator.

68. The start cartridge according to Claim 67, wherein the biasing member is a coil spring.

69. The start cartridge according to Claim 57, wherein the initiator defines a beveled contact surface.

70. An initiator for initiating a pilot arc in a plasma arc torch, the initiator being movable against a resilient bias to establish a pilot arc between the initiator and a tip within the plasma arc torch.

71. The initiator according to Claim 70, wherein the initiator defines a beveled contact surface.

72. The initiator according to Claim 70 further comprising a plurality of vent holes to vent a working gas from the initiator.

73. The initiator according to Claim 72 further comprising a proximal face, recessed proximal face, and an annular wall formed between the proximal face and the recessed proximal face, wherein the vent holes are formed through the annular wall.

74. The initiator according to Claim 70 further comprising a plurality of axial vent holes to vent a working gas from the initiator.

75. An initiator for initiating a pilot arc in a plasma arc torch, the initiator being movable against a resilient bias to establish a pilot arc between the initiator and a tip within the plasma arc torch, the initiator comprising:

a proximal face;

a recessed proximal face;

an annular wall formed between the proximal face and the recessed proximal face; and

a plurality of vent holes are formed through the annular wall,

wherein the vent holes vent a working gas from the initiator.

76. A plasma arc torch head for use with a fixed electrode, a fixed tip, and a source of gas and electric power for initiating a pilot arc comprising:

head vent holes disposed at a proximal section of the torch head, wherein the vent holes vent at least a portion of the gas from the torch head.

77. The plasma arc torch head according to Claim 76 further comprising:

an insulating body defining a plurality of axial vent holes and radial vent holes; and

an anode disposed around the insulating body, the anode defining a plurality of radial vent holes,

wherein the vent holes are in fluid communication to vent the gas from the torch head.

78. A plasma arc torch comprising:

a torch head comprising:

a housing;

a cathode disposed within the housing and connected to a supply of gas and electric power;

an anode disposed within the housing and connected to the supply of gas and electric power;

an insulating body disposed between the cathode and the anode;

an electrode removably engaged with the cathode;

a tip in a spaced relationship with the electrode;

a shield cup removably engaged with the anode; and

an initiator resiliently biased into contact with the tip, the initiator being movable against the resilient bias to separate from the tip and establish a pilot arc between the initiator and the tip.

79. The plasma arc torch according to Claim 78 further comprising a start cartridge disposed between the electrode and the tip, the start cartridge comprising:

a cartridge assembly;

a biasing member disposed within the cartridge assembly; and

the initiator disposed within the cartridge assembly,

wherein the biasing member biases the initiator into contact with the tip.

80. The plasma arc torch according to Claim 79, wherein the cartridge assembly further comprises a cartridge body and a tip seat secured to a distal portion of the cartridge body.

81. The plasma arc torch according to Claim 80, wherein the cartridge body further comprises a plurality of radial gas holes that direct a portion of a working gas into the start cartridge to overcome the bias of the biasing member to move the initiator.

82. The plasma arc torch according to Claim 80, wherein the cartridge body further comprises a plurality of gas passages that direct a portion of a working gas into the start cartridge to overcome the bias of the spring to separate the initiator from the tip.

83. The plasma arc torch according to Claim 80, wherein the cartridge body further comprises a plurality of axial vent holes to vent a working gas from the start cartridge.

84. The plasma arc torch according to Claim 83, wherein the cartridge body further comprises a plurality of proximal radial holes to direct the working gas.

85. The plasma arc torch according to Claim 80, wherein the cartridge body further comprises an internal annular flange and at least one gas passage formed in the cartridge body that vent a portion of the working gas along a central portion of the electrode and through the start cartridge.

86. The plasma arc torch according to Claim 80, wherein the cartridge body is conductive and the tip seat is insulative.

87. The plasma arc torch according to Claim 80, wherein the cartridge assembly further comprises a conductive member disposed at a proximal end of the cartridge body, and the cartridge body and the tip seat are insulative.

88. The plasma arc torch according to Claim 78, wherein the initiator further comprises a plurality of vent holes that direct a portion of the working gas along a central portion of the electrode.

89. The plasma arc torch according to Claim 78, wherein the insulating body further comprises a plurality of axial vent holes and radial vent holes in fluid communication with the cartridge body axial vent holes, and the anode further comprises a plurality of radial vent holes in communication with the insulating body radial vent holes to vent the working gas from the start cartridge.

90. The plasma arc torch according to Claim 78 further comprising a conductive insert disposed within the shield cup and in electrical contact with the tip and the anode.

91. The plasma arc torch according to Claim 78, wherein the electrode defines a central portion that comprises spiral grooves.

92. The plasma arc torch according to Claim 78, wherein the electrode defines a central portion that comprises axial grooves.

93. A plasma arc torch comprising:

an electrode;

a tip; and

a start cartridge disposed between the electrode and the tip, the start cartridge further comprising:

a cartridge body;

a tip seat secured to a distal portion of the cartridge body;

a biasing member disposed within the cartridge body; and

an initiator disposed within the cartridge body, the initiator being resiliently biased into contact with the tip by the biasing member, the initiator being movable against the resilient bias to separate from the tip and establish a pilot arc between the initiator and the tip.

94. A method of initiating a pilot arc in a plasma arc torch, the method comprising the steps of:

biasing an initiator into contact with a tip;

providing a source of gas and electric power; and

directing at least a portion of the gas to overcome the bias to separate the initiator from the tip,

wherein the pilot arc is drawn between the initiator and the tip as the bias is overcome.

95. The method according to Claim 94 further comprising the step of venting the portion of gas used to overcome the bias through head vent holes in a torch head.

96. The method according to Claim 94 further comprising the step of directing another portion of the gas through the tip for swirling the gas to form a plasma stream and for providing a secondary gas flow to stabilize the plasma stream.

97. A method of venting gas from a plasma arc torch comprising a fixed electrode and a fixed tip, the method comprising the steps of:

providing a source of gas and electric power;

directing the gas and electric power to initiate a pilot arc; and

venting at least a portion of the gas through head vent holes.

98. The method according to Claim 97 further comprising the steps of:

venting the gas through a start cartridge;

venting the gas through an insulating body;

venting the gas through an anode; and

venting the gas through an opening in a shield cup.

99. A method of initiating a pilot arc in a plasma arc torch, the method comprising the steps of:

providing a source of gas to move an initiator into contact with a tip;

providing a source of electric power; and

moving the initiator away from contact with the tip to draw an arc between the initiator and the tip.